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February 27, 1995

VIA MESSENGER

William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
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Re: ET Docket No. 93-7
Notice of Ex Parte Communication

Dear Mr. Caton:

On Thursday, February 23, representatives of Echelon Corporation met with Mark A. Corbitt, Director, Technology Policy of the Commission's Office of Plans and Policy. In addition to a discussion of Echelon's distributed control networking technology, the meeting addressed Echelon's views regarding the proposed decoder interface in ET Docket No. 93-7, as reflected in Echelon's previous *ex parte* filing of February 9, 1995. The attached handouts were distributed. Representing Echelon were Oliver R. Stanfield, Vice President and CFO, Drew Hoffman, Vice President of Engineering, and Robert A. Dolin, Director-Systems Engineering, along with the undersigned and Jeffrey Blumenfeld of this law firm, counsel to Echelon.

Pursuant to Section 1.1206 of the Commission's Rules, two copies this letter are enclosed for filing. Please contact me should you have any questions in regard to this matter.

Sincerely,

Glenn B. Manishin

GBM:hs
Enclosures
cc (w/o encl.): Mark A. Corbitt

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DRAFT
IS-XX Audio/Video (AV) Bus Physical Layer and Media Specifications

1 Introduction
This document is the preliminary specification for the Audio/Video (AV) Bus Physical Layer and Media. Its purpose is to present all of the information necessary for the development of an AV physical network and devices to communicate and share information over that network.

This document covers the complete Physical Layer (OSI layer 1) including the interface to the Medium Access Control (MAC) Layer and the interface to the medium. The document also provides a complete set of physical and electrical specifications for the medium and the specification for a number of data channels available on the medium.

NOTE: Italicized sections in this paper are editorial comments.
Certain items require experimental data which is unavailable at this time; these are marked To Be Determined (TBD).

1.1 Safety Preamble
This preamble sets forth a number of recommendations related to safety concerns with respect to the AV Bus Draft Standard.

This discussion is not complete, nor does it address all possible safety issues. The designer is urged to consult, among other things, the relevant local and national electrical codes. Local codes usually supplement the national electrical code and impose additional safety related requirements.

It is strongly recommended that products conforming to the AV Bus Draft Standard be designed, constructed, assembled, and installed in accordance with recognized safety provisions appropriate to products covered by the standard.

AV Bus network cables as described in this standard are subject to potential electrical safety hazards during their use. These hazards are:

- Direct contact between network cable and components and power or lighting circuits.
- Potential differences between safety grounds to which network components are connected

These electrical safety hazards should be alleviated whenever possible for the network to perform properly.

1.3 Scope
This document contains the performance specifications necessary to implement an Audio/Video (AV) bus to carry baseband audio, video, and control signals for limited distances between consumer audio and video equipment in the home. The document is divided into six major sections:

1 - An introduction to the AV standard.

2 - A general description of the AV network design.

3 - The specifications of the allowed topology and configuration rules - this section covers network components, allowed wiring configurations, and attachment of devices.

4 - A specification of the AV physical medium - this section covers frequency allocation of the medium, cable usage, the physical and electrical specification of the medium, connectors, environmental requirements, and installation considerations.

5 - The Physical Layer specifications of an AV device - covers the interface to the higher ISO layers, control channel signal characteristics, data channel signal criteria, encoding, transmitter and receiver characteristics, and device failure modes.

6 - The CEBus Node 0 requirements for support of the AV network - covers the CEBus Node 0 components and requirements for successful network operation including control channel routing and data channel bridging criteria.

The standard establishes a minimum set of rules for compliance. It does not rule out extended services to be provided, as long as the rules are adhered to within the system. It is in fact the intention of the standard to permit extended services (defined by users) to coexist.

Certain aspects of the standard are defined in other documents. These documents will be referenced when relevant. In the case where a referenced standard conflicts with this document, this document will prevail.

1.4 Definitions and Abbreviations.

The following definitions are specific to the AV bus specification and supplement the definitions and abbreviations found in EIA IS-60.1.

baseband - In the AV Bus context, a signal appearing on a media which is directly represented by a voltage or current condition on the media and is not modulated onto another carrier signal of higher frequency.

circuit common - the zero reference of the AV device power supply and/or the device signal reference ground.

SVHS - Abbreviation for Super-VHS, an enhanced version of the VHS video format.

S video-Y - The separated luminance signal component of an SVHS signal.

S video-C - The separated chroma signal component of an SVHS signal

1.5. Relation of Specification to the CEBus model.

The AV Bus adheres to the CEBus model which is based on the OSI Reference Model. It is a 7-layer model (with some layers being null). There are also important extensions to the OSI Reference Model; CEBus has physical channels available on its media which can be allocated through resource management to various applications. This document specifies the following:

1. Physical layer of Control Channel
2. The physical media and device interface to the media
3. The data channels

Figure 1.1 below shows the scope of this specification in reference to the entire CEBus model. Here, only those aspects of the model relevant to the AV bus medium are specified. Anything outside of the boundary is either specific to another medium distinct from AV, or is generic in nature and applies across all CEBus media.

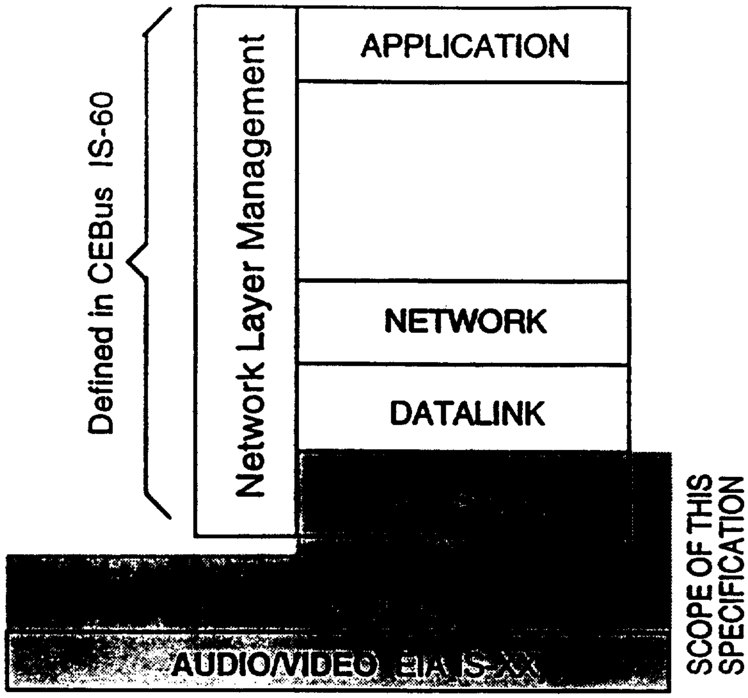

Figure 1.1 Relation of AV Bus Specification to IS-60 Model

2 General Description.

The AV bus is designed for the interconnection of audio/video equipment in a local area such as might exist in an entertainment equipment rack or cluster within a home. The bus consists of 10 twisted pair lines designed to support baseband audio and video signals over distances less than 10 meters, and is composed of the following:

- One pair dedicated for the CEBus control channel
- Four pair dedicated for audio bandwidth signals
- Four pair dedicated for video bandwidth signals

Physically, the bus consists of one or more AV bus cables (with connectors on each end) connected from one CEBus AV bus device to the next. Each A/V device has one or two connectors for from/to interconnection from a previous or next device. Two or more such devices comprise an AV bus network.

2.1 Functional Partitioning of AV Specification

This specification divides the complete AV environment into three basic parts: the network topology, the physical medium, and the device physical access specification. Figure 2.1 illustrates this partitioning as it relates to each part of the AV environment.

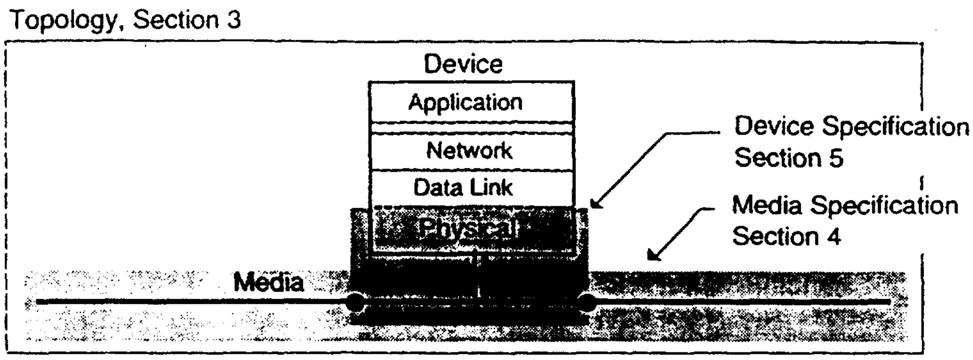

Figure 2.1 AV Specification Partitioning

The Topology specification deals with the anticipated configurations of AV wiring likely to be found in the majority of installations.

The Device specification deals with the physical properties of that part of the device which makes contact with the medium. Also described is the interface between the Physical Layer and the Symbol Encoding Sublayer.

The Medium specification concerns the capabilities and properties of the physical medium. This encompasses such items as its bandwidth, frequency allocation, electrical and physical specifications, connectors, etc.

3. AV Network Topology

The following Section deals with the physical topology of the AV network. Described is the allowed configurations of AV wiring, device connection, and minimum and maximum configurations.

3.1 AV Network Specification

3.1.1 AV Network Components

Figure 3.1 is a functional representation of the AV network. An AV network consists of two or more AV bus devices interconnected by an AV bus cable.

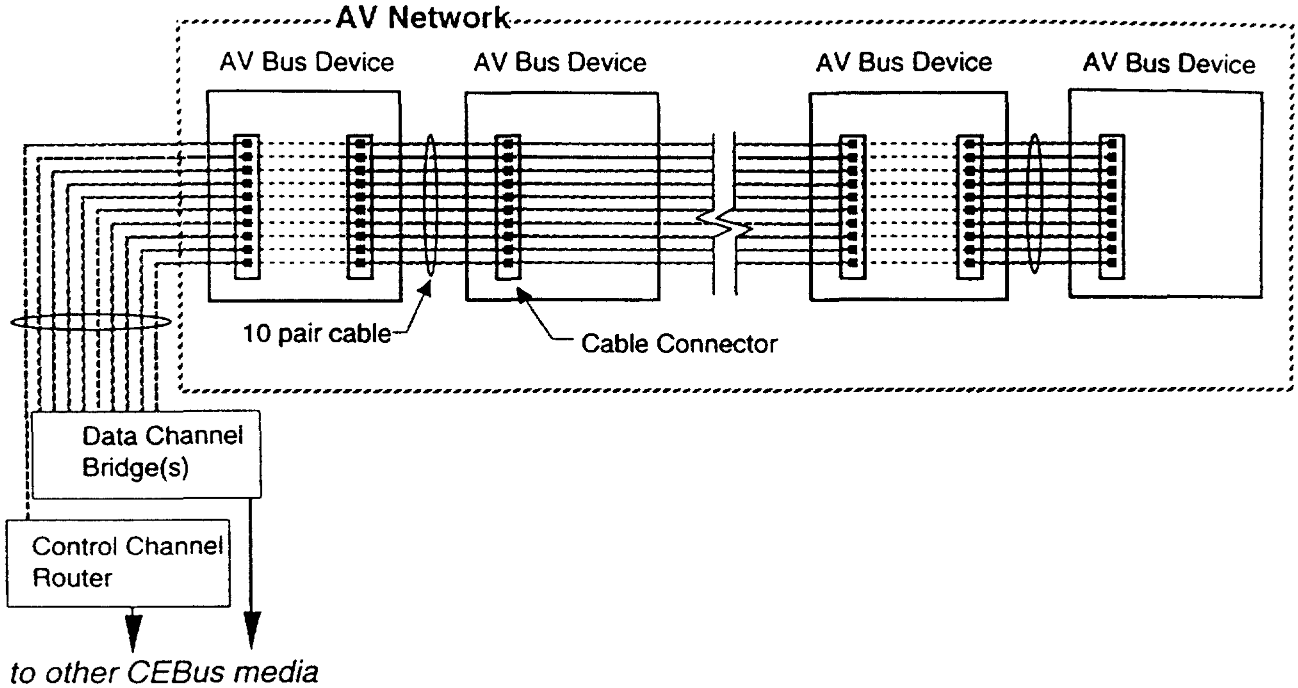

Figure 3.1 Basic CEBus Topology

The AV bus cable consists of ten individual twisted pairs to carry the control channel, four audio lines, and four video lines with one pair being used as a common mode reference (CMR) line. The cable is jacketed with a 20 conductor connector at each end. Figure 3.2 illustrates the construction and line naming of each pair of the cable.

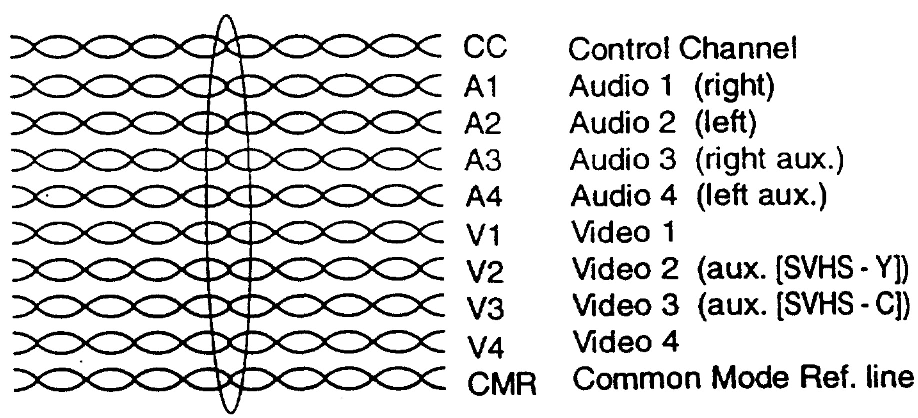

Figure 3.2 AV Bus Cable

The "Opt. Router" and "Data Bridge(s)" section shown in Figure 3.1 contains any optional control channel router and any data channel bridges for interconnection between AV networks and/or other CEBus media and is discussed in Section 6.

3.1.2 AV Bus Extensions

The optional extension of the AV bus, to include additional audio and video lines (in an additional cable), is under study. The additional lines would be under allocation control of the basic cable control channel requests. Any device which used the extension cable would be required to use the basic cable.

The basic cable may be referred to as AV 1 or AVb (basic). The extension cable would be referred to as AV 2 or AVe (extension)

The extension cable would use the same type of connectors as the basic cable but of opposite "gender" (i.e. the extension cable would use female plugs on the cable and male connectors on the equipment.

3.1.3 Allowed Topologies

Each AV network shall consist of two to ten devices interconnected with an AV bus cable. Each device will have one or two connectors for attachment of a cable from/to other devices. If two connectors are used, all twisted pairs will be internally connected in parallel from one connector to the other connector.

More than one AV network can exist in the home allowing connection between control channel lines by way of control channel routers. Any number of AV networks can be added in this manner.

3.1.4 AV Configuration Rules

AV networks shall be constructed according to the following rules. These rules are intended to minimize signal distortion (due to attenuation and reflections), signal and power loading, and assure reliable operation. Figure 3.3 illustrates these configuration requirements.

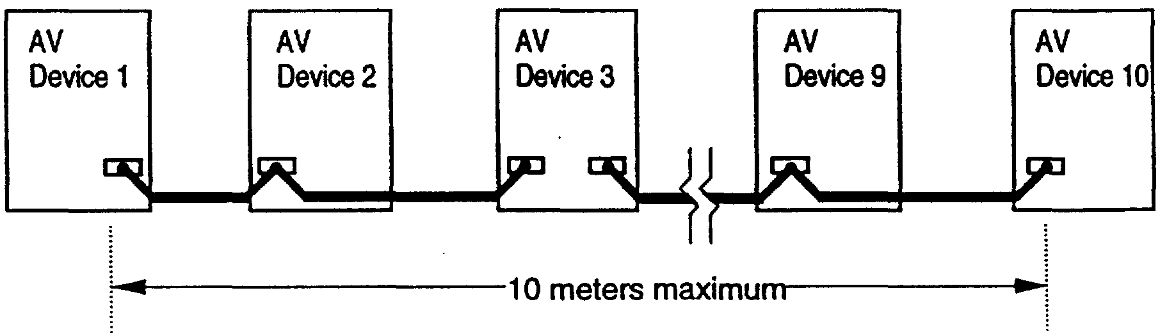

Figure 3.3 AV Network Branch

- A maximum of 10 AV devices may be attached to a single AV bus. If a separate router or data bridge device is attached to the network, the device counts as one of the allowed 10 AV devices.

- The maximum length of the AV network shall not exceed 10 meters.

- The maximum length of a single AV cable shall not exceed 10 meters.

- The first and last device on the bus shall terminate the four video lines by the manual attachment of a terminating device or selection of device termination.

- AV Cables may begin and end in only one connector, or they may have provision at either of both ends for attachment of another cable to allow "daisy chain" style attachment to devices with only one AV bus connector.

3.1.5 Junctions and Splices

Extending AV cables by junction or splicing devices is not permitted.

4. AV Medium Specifications

This Section specifies properties to which the AV bus media (cable) must conform. Both mechanical and electrical properties are specified. The specifications in this Section concern the medium sub-layer of the Physical Layer and apply to all configurations from fully loaded systems (those with the maximum allowable number of devices attached at maximum length), to systems with the minimum configuration.

4.1 Usage Rules

CEBus defines uses for each of its media. This usage must adhere to CEBus standards for electrical, access and frequency allocation.

Any combination of the AV bus lines available can be used by a device application from a minimum of one to a maximum of eight. AV bus lines are designated CC for control channel; A1, A2, A3, and A4 for the four audio lines; V1, V2, V3, and V4 for the four video lines; and CMR for the common mode reference pair.

The CC line is reserved for use by the control channel.

The audio lines (A1, A2, A3, A4) are reserved for use by baseband audio spectrum signals. A1 and A3 are recommended for use as audio right channels. A2 and A4 are recommended for use as audio left channels.

The video lines (V1, V2, V3) are reserved for use by baseband video spectrum signals. V4 can be used for any signal meeting the limitations of the video transceiver specifications of section 5.7.2.

4.2 Frequency Allocation

The AV Bus does not allocate frequency resources on its media. Rather, each medium is reserved for a particular class of use and the frequency spectrum on each medium is a function of the application and physical limitations of the medium. There are no specific frequency allocations given and it is assumed each application will use a baseband signal whose upper limit and amplitude meets the requirements of this specification.

The control channel on CC is completely specified in terms of data rate, waveform, amplitudes, and timing.

4.3 Data Channel Resource Allocation

The CEBus IS-60 resource allocation protocol can be used to allocate AV bus lines if each AV audio and video line is treated as a data channel resource. This allows CEBus CAL resource allocation commands to allocate one or more bus lines for use by an application. Each line is treated as a data channel resource and data channel numbers are assigned to each line and combination of lines.

The following table provides the relationship between the assigned data channel numbers and data channel resources (AV bus lines). The channel numbering is designed to allow for allocation of future AV bus extension lines.

	Bus Line	*Single Channels*	*2 channels*	*4 channels*	*Complete Bus*
First (basic) group of AV data ch. lines	A1	1	2		
	A2	3		4	
	A3	5	6		
	A4	7			8
	V1	9	10		
	V2	11		12	
	V3	13	14		
	V4	15			
Second (extension) group of AV data ch. lines	A1	17	18		
	A2	19		20	
	A3	21	22		
	A4	23			24
	V1	25	26		
	V2	27		28	
	V3	31	30		
	V4	33			
Additional AV lines (future ext.)					

To allocate one or more data channels (lines) for an application, a CAL resource allocation command is used. These commands are outlined in the Data Channel Transmitter and Data Channel Receiver Object contained in the IS-60 CAL Object definition tables. To request one or more lines, the IF method is used to perform a network query for the availability of the resource. See IS-60.08, the CAL Application Language. The CAL medium number for the AV bus is six (6).

The channel number assigned to each line and group of lines allows a simple encoding/decoding algorithm to determine both the number of lines requested and the specific starting group of lines. The least significant first non-zero bit indicates the number of lines requested

If the 2^0 bit is set, one line is requested
If the 2^1 bit is set, two lines are requested
If the 2^2 bit is set, four lines are requested (or three lines in the case of video lines)
If the 2^3 bit is set, all audio and video lines in a bus group are requested

To determine whether the requested lines can be allocated, the following algorithm can be used. If CIU = current channel in use, and RC = requested channel then:

If ($|RC-CIU|$ <= Requested number of lines) then deny the request.

4.4 Mechanical Specifications

4.4.1 Cable Construction

The cable used for the AV network shall consist of twisted, 10-pair 28 AWG stranded wire (discrete or ribbon cable) covered by a PVC jacket. The jacket material shall be flexible PVC or polypropylene having a thickness of at least 0.02". The nominal outside diameter of the cable should be less than 0.30".

Pair Lays in the cable should be varied to minimize crosstalk.

4.4.2 Pair Construction

Each twisted pair in the cable will consist of 28 AWG stranded wire. The insulation of each twisted pair shall be PVC or polypropylene having a thickness of 0.0045" ±0.0005" and have the following color coding:??

Do we care what the color coding of each pair is??

Each pair will have at least XX twists per inch. The twists per inch should be varied between pairs to minimize crosstalk.

4.5 Electrical Specifications

4.5.1 Cable Electrical Characteristics

Twisted Pair cable used for the AV network will meet the following set of electrical characteristics:

Characteristic	Minimum	Maximum
DC resistance (per 1000'): 28 AWG:		70Ω
Mutual Capacitance between wires of same pair:		20 pf/ft.
Stray Capacitance between 1 wire in pair to all other wires connected to ground:		40 pf/ft.
Attenuation (per 1000') at 1 KHz:		0.5 dB
at 1 MHz:		7.8 dB
Characteristic Impedance at 1 KHz:	??Ω	??Ω
at 1 MHz:	??Ω	??Ω

Additionally, the resistance unbalance between the two conductors of any AV pair shall not exceed 5%.

4.5.2 Insulation Leakage Resistance
The leakage resistance between any two wires of any AV pair will be greater than 1M ohms.

4.5.3 **Termination**
Termination of Audio bus pairs is not required.

Termination of Video bus pairs shall be 120Ω at the first and last device attached to the AV bus. Termination may be provided externally or, optionally, internally to the AV device by a selection mechanism.

4.6 Connectors
The AV bus cables and devices will utilize a special miniature insulation displacement style connector containing twenty single conductor contacts. The bus cables will use male connectors on each end. AV bus devices will use female connectors.

4.6.1 Connector Physical Specifications
The connector used for the AV bus will be a 20 pin insulation displacement device using a positive mating snap-in lock mechanism. The connector will use 50 mil spacing leaf spring type contacts in two rows capable of repeated connection and disconnection. A diagram of the connector is show in figure 4.1.

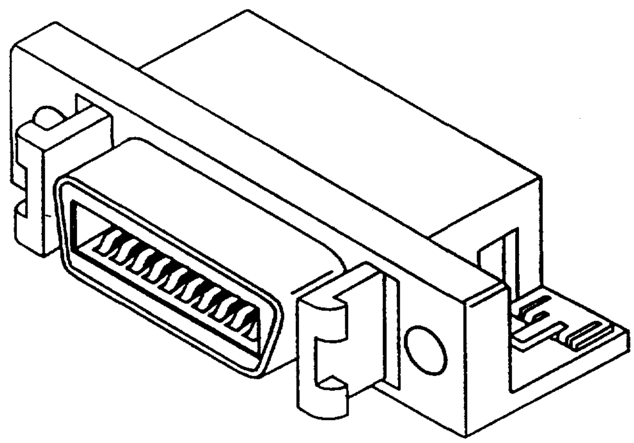

Figure 4.1 A/V Connector (male)

The physical outline and dimensions for the connector is given in Figure 4.2 and Figure 4.3 below. The connector show is the receptacle (female) end for AV equipment. The dimensions shown are nominal.

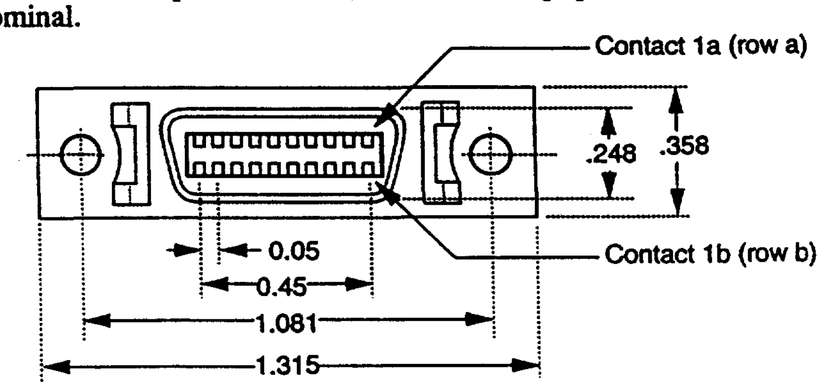

Figure 4.2 A/V Connector (female, equipment) elevation and pin numbering (shown 2X)

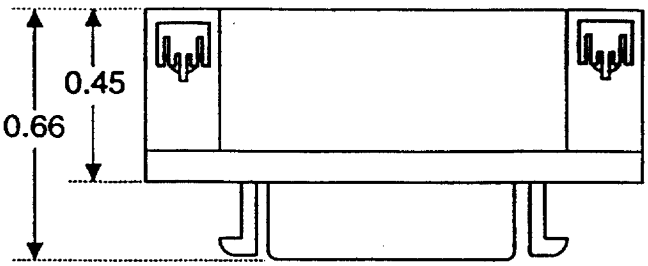

Figure 4.3 A/V Connector (female, equipment) plan view (shown 2X)

The connector numbering is shown as seen from the outside of an AV bus device. The cable connector will use the mating plug (male). The plug covering and mechanical attachment to the cable is not specified.??

Connector contacts will be beryllium copper with gold over nickel in the contact area and tin over nickel in the termination area.??

The connector specified is intended to be equivalent to the following commercially available parts:

JAE TX10 series
AMP CHAMP Series II

While the JAE and AMP connectors are physically similar, the pin numbering for the connectors uses different nomenclature.

PIN and SIGNAL Assignments

Function	JAE Pin	AMP Pin	wire color
Video 4+	1b	1	TBD??
Video 4 -	2b	2	
Audio 3 +	3b	3	
Audio 3 -	4b	4	
Video 2 +	5b	5	
Video 2 -	6b	6	
Audio 1 +	7b	7	
Audio 1 -	8b	8	
Video 1 +	9b	9	
Video 1 -	10b	10	
Audio 4 +	1a	11	
Audio 4 -	2a	12	
Video 3 +	3a	13	
Video 3 -	4a	14	
Audio 2 +	5a	15	
Audio 2 -	6a	16	
GND	7a	17	
GND	8a	18	
CC -	9a	19	
CC +	10a	20	

4.6.2 Electrical Specifications

The connector and connector contacts will meet the following minimum specifications:

Characteristic	Value
Current capacity	0.5A per contact
Voltage rating	250V AC rms
Dielectric breakdown	500V AC rms between contacts
Insulation resistance	500 Mohms between contacts
Contact resistance	35 milliohms maximum

4.7 Environmental Requirements

This Section specifies the environment in which the AV Bus system must function. Certain requirements are outside the scope of this standard; in these cases, requirements or guidelines set by other regulatory bodies should be observed.

4.7.1 Temperature and Humidity

The AV network is expected to operate within electrical specifications over a temperature and humidity range appropriate to the application. It is the responsibility of the manufacturers of AV Bus compatible equipment to design to an adequate temperature and humidity operating range that will insure reliable operation in the intended areas of use in the home. The manufacturer should inform the user of the range selected for the product.

4.7.2 Electrical Overstress/Transients

The AV network and each AV device attached to the AV network must be capable of withstanding, without permanent damage, an electrical discharge from a 200pf capacitor through a 150Ω (max) non-inductive resistor. The capacitor is charged to a plus or minus voltage. Under the specified discharges voltages, the following conditions must prevail.

- <15KV - No "soft" failures will occur. No device state changes or damage to hardware will occur.
- 15KV to 20KV - No "medium" failures will occur. No unusual user action to restore service will be required and no damage to hardware will occur. State changes are permitted if the normal user controls can restore proper operation.
- 20KV to 25KV - No "hard" failures will occur. No damage to device hardware will occur. Unplugging the device from the power is permitted to restore proper operation.

Where is discharge from - to??

4.7.3 Radiated RFI/EMI

The complete AV system of wire and attached node equipment shall meet the requirements of FCC Part 15 Rules for electromagnetic radiation of unintentional radiators.

Signals coupled to any AV cable pair must be frequency constrained to limit rise time to meet acceptable limits of emitted radiation due to harmonics and to limit induced noise into other AV pairs.

5. AV Device Specifications

This Section covers the Physical Layer specifications of the AV device including:

- the Physical Layer interface to the Symbol Encoding Sublayer,
- the Physical Layer interface to the Application Layer,
- the physical signaling characteristics used on the AV media,
- the specification of the transmitter needed to generate the necessary AV bus signals,
- the specification of the receiver needed for proper reception of AV bus signals.

5.1 SE Sublayer to Control Channel Physical SubLayer Interface

The MAC sublayer to Physical Layer interface is detailed in IS-60.03, Part 7 which defines a media-independent sublayer of the Physical Layer that performs symbol encoding and timing. This Section will deal with the interface between the SE Sublayer and the Physical Sublayer which is always assumed to be different for each media. The SE Sublayer is assumed to provide the necessary encoding of the AV Bus symbols (1,0,EOF, EOP) into the necessary requests for SUPERIOR or INFERIOR states on the media for the required period of time and, likewise, encode the presence of SUPERIOR or INFERIOR states indicated on the medium into AV Bus symbols.

5.1.1 Relation of SE Sublayer to Physical Sublayer

Figure 5.1 shows the relationship of the Physical Sublayer to the SE Sublayer. This document deals only with the shaded areas in the Figure.

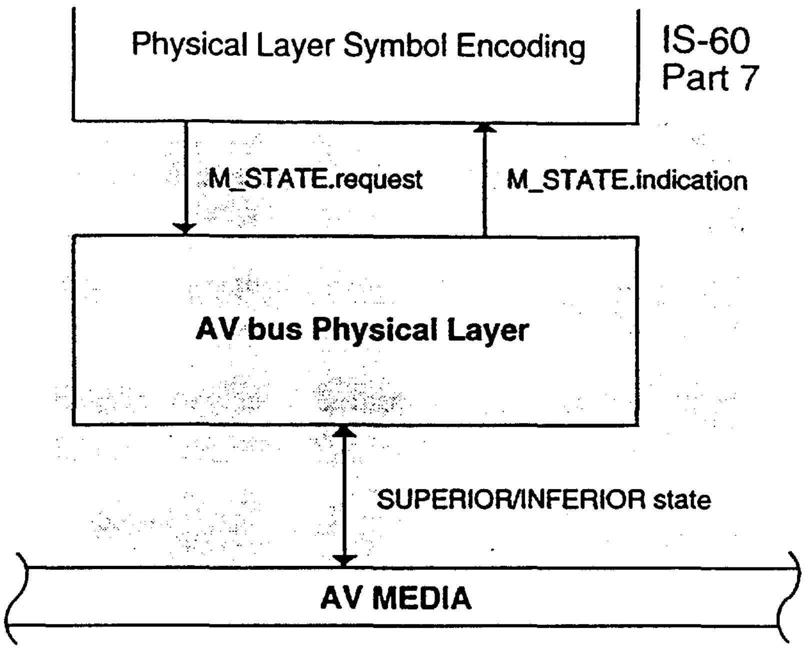

Figure 5.1 Relationship of Physical Sublayer to SE Sublayer

5.1.2 Service Primitive Definition

The following service primitives provide an interface between the SE Sublayer to and from the Physical Layer. The Physical Layer is assumed to contain all the necessary hardware (transmitter, receiver, etc.) necessary to perform the proper signaling on the media.

5.1.2.1 Physical Layer to SE Sublayer

The Physical Layer's responsibility is to report the state of the medium to the SE Sublayer. This is performed using the following service primitive:

M_STATE.indication(SUPERIOR | INFERIOR)

Whenever the Physical Layer detects the transition from SUPERIOR to INFERIOR or from INFERIOR to SUPERIOR the service primitive is used with the corresponding argument (SUPERIOR or INFERIOR).

5.1.2.2 SE Sublayer to Physical Layer

The SE Sublayer is responsible for directing the Physical Layer to send the SUPERIOR state, the INFERIOR state, or to toggle from the current state to the opposite state. This is performed using the following service primitive:

M_STATE.request(SUPERIOR | INFERIOR | TOGGLE)

The Physical Layer will remain in the last state requested by this service primitive until a different argument is passed (SUPERIOR if in INFERIOR, or INFERIOR if in SUPERIOR) or the TOGGLE argument is used.

5.2 Application Layer to Data Channel Physical Layer Interface

Access to the media Data Channel is controlled directly by the interaction of the device application layer and the device resource management entity. Access is requested and granted/ denied via service requests passed over the control channel.

The Application layer to Physical Layer interface is defined by a set of abstract service primitives and are not intended to imply any particular implementation. The service primitives provided by the Physical Layer allow the local application to establish a connection to the media for transfer of data with peer application layer entities at other nodes designed to be compatible at the Physical Layer (i.e. their physical signaling methods are the same). It is the responsibility of the resource management entity to make sure access has been logically granted since there is no provision in the Physical Layer to detect any data channel collision.

5.2.1 Data Channel Service Primitives.

The service primitives for the data channel define the request for access to the channel and provide for the status of the connection to the channel. It is assumed information on the data channel is automatically available to and from the application, thus no service primitive for the data need be defined.

5.2.1.1 PH_DC_ALLOCATE.request

This service primitive defines the request for access to a particular data channel on the AV media. The semantics of this primitive are as follows:

PH_DC_ALLOCATE.request (medium)

The result of this request is a physical signaling connection from the application layer to the medium requested. This connection is assumed to meet all of the two way data transfer requirements of the application.

5.2.1.2 PH_DC_CONFIRM.indication

This service primitive provides the application layer with confirmation that contact has been established with the data channel. The semantics of this primitive are as follows:

PH_DC_CONFIRM.indication(status)

The "status" parameter may take on one of the following values: "READY", "NOT-READY", or "PH_FAILURE". The PH_DC_CONFIRM.indication service primitive is sent from the Physical Layer to the application layer each time a change in the status parameter occurs.

The status value of "READY" indicates contact with the physical data channel is established as requested and is provided as a result of a data channel allocate request.

The status value of "NOT-READY" indicates connection to the data channel has not been made or has been broken per an allocate request.

A status value of "PH_FAILURE" indicates the Physical Layer has detected its own failure. The ability to detect and report Physical Layer failures is optional. This parameter value will always be available, but implementations which do not include a Physical Layer failure capability will simply never return a status value of "PH_FAILURE".

5.3 Control Channel Signal Characteristics

This Section describes the encoding, data rate, and symbol definition for AV Bus control channel signaling over the AV bus network.

5.3.1 Control Channel Signal Encoding

The TP control channel will employing two differential bipolar signal levels to encode the CEBus symbols "1", "0", "EOF", and "EOP". The two signal levels are used to represent the two media states of SUPERIOR and INFERIOR. An INFERIOR state is represented by the presence of nominal -0.6V differential level present on the CC pair. The SUPERIOR state is represented by the presence of a nominal +0.65V differential level on the CC pair.

The encoding of the symbols is strictly related to the time the INFERIOR or SUPERIOR state remains on the media, not whether the INFERIOR or SUPERIOR state is used. Any symbol can be defined by either a SUPERIOR or INFERIOR state.

The "1" symbol is represented by the shortest interval of the SUPERIOR or INFERIOR state, the "0" is twice the interval of the "1", the "EOF" is three intervals, and the "EOP" is four intervals. Figure 5.2 shows an example of this encoding. The voltage levels shown are measured from the CC+ terminal with respect to the CC– terminal.

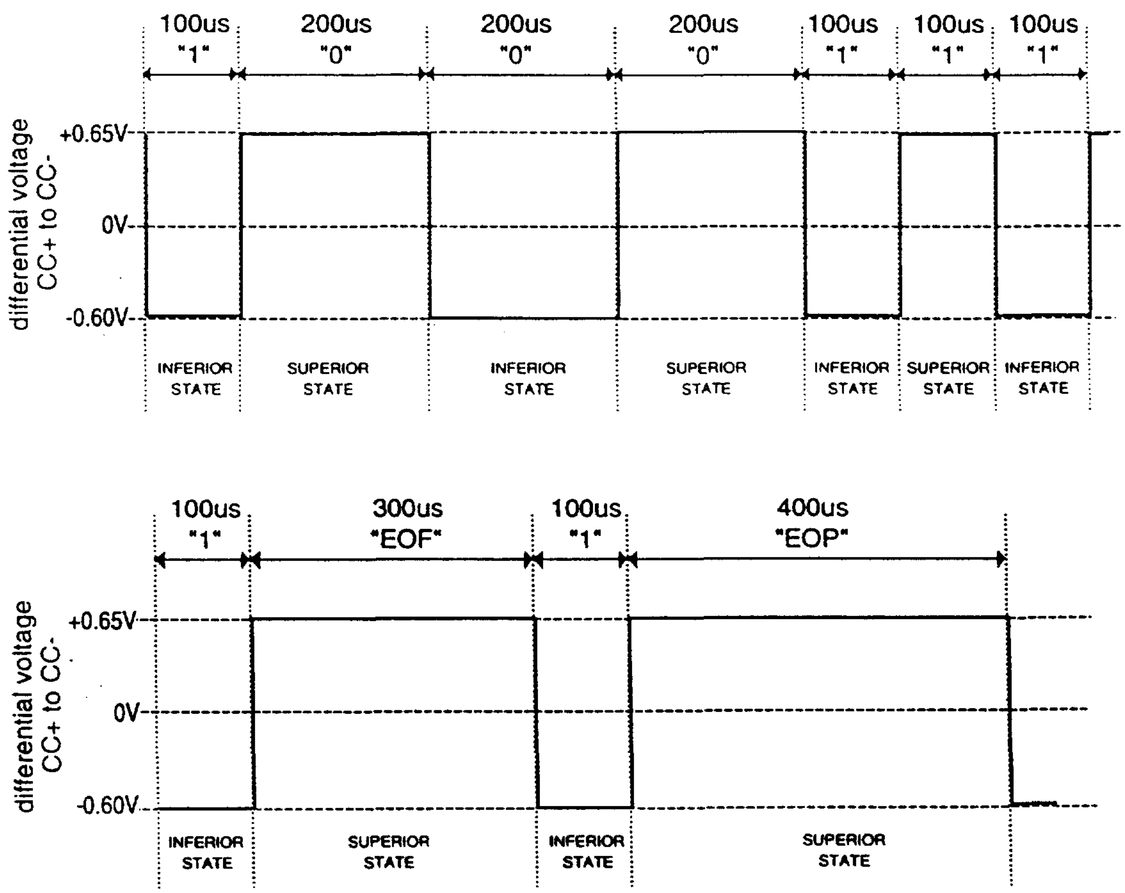

Figure 5.2 AV Encoding Example

5.3.2 Signaling Rate and Symbol Timing

The signaling rate for AV control channel will be 10K ONE bits per second ± 5% over the operating temperature and humidity range of the attached device.

This rate gives the following symbol times for the four AV Bus encoded symbols:

ONE	100 µs	± 5µs
ZERO	200 µs	± 5µs
EOF	300 µs	± 5µs
EOP	400 µs	± 5µs

The symbol time for the shortest symbol (ONE) will be defined as the "unit symbol time" and represents the minimum SUPERIOR or INFERIOR period.

5.5 Control Channel Transmitter Characteristics

The control channel transmitter shall be a balanced driver capable of generating the specified control channel signals onto the CC pair. Only the parameters necessary to ensure compatibility with the control channel receiver are specified in the following sections.

5.5.1 SUPERIOR Output State

Upon reception of M_STATE.request(SUPERIOR), or M_STATE.request(TOGGLE) while in the INFERIOR state, the transmitter will generate the SUPERIOR state. The transmitter shall meet the following requirements for successful SUPERIOR state generation.

While in the SUPERIOR state, the differential output voltage magnitude, Vdif, into the test load shown in Figure 5.4 at the connector of the device, shall be between +0.50V and +0.80V from CC+ with respect to CC- in either position of the switch. The maximum output current during the SUPERIOR state will be limited to +10 mA into a short circuit at the output terminals.

The transmitter will maintain the SUPERIOR state while in the presence of a common mode voltage range of +2V to +7V appearing at the device output terminals with respect to the CMR line.

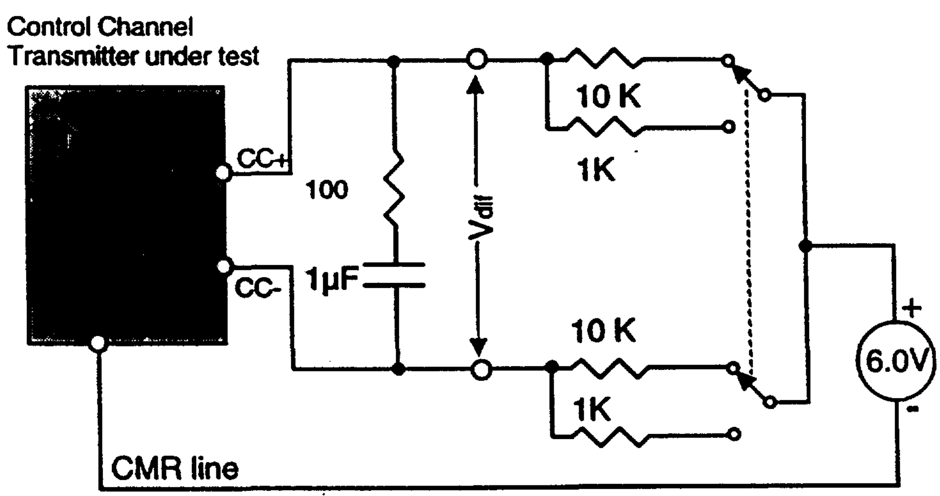

Figure 5.4 Output Driver Test Circuit

5.5.2 INFERIOR Output State

Upon reception of M_STATE.request(INFERIOR), or M_STATE.request(TOGGLE) while in the SUPERIOR state, the transmitter will generate the INFERIOR state. The transmitter shall meet the following requirements for successful INFERIOR state generation.

While in the INFERIOR state, the differential output voltage magnitude, Vdif, into the test load shown in Figure 5.4 at the connector of the device shall be between -0.50V and -0.80V from CC+ with respect to CC-. The maximum output current during the INFERIOR state will be limited to -0.45 mA into a short circuit at the output terminals.

The transmitter will maintain the INFERIOR state while in the presence of a common mode voltage range of +2V to +7V appearing at the device output terminals with respect to the CMR line.

5.5.3 Timing

The output voltage signal shall remain within the timing and voltage levels depicted in figure 5.5 and meet the following timing specifications:

Parameter	Description	Min.	Typ.	Max.	Units
t_{PER}	SUPERIOR State Period	95	100	105	µs
t_{I2S}	SUPERIOR transition	1.6	3.2	6.4	µs
t_{S2I}	INFERIOR transition	1.6	3.2	6.4	µs

Where: t_{PER} : Superior state time for unit symbol time.
t_{I2S}: Inferior to Superior transition time. Time to reach +0.50 volts from the Inferior voltage level on the bus.
t_{S2I}: Superior to Inferior transition time. Time to transition from -0.50 volts to the Inferior voltage level on the bus.

These conditions are measured while driving the test load of Figure 5.4.

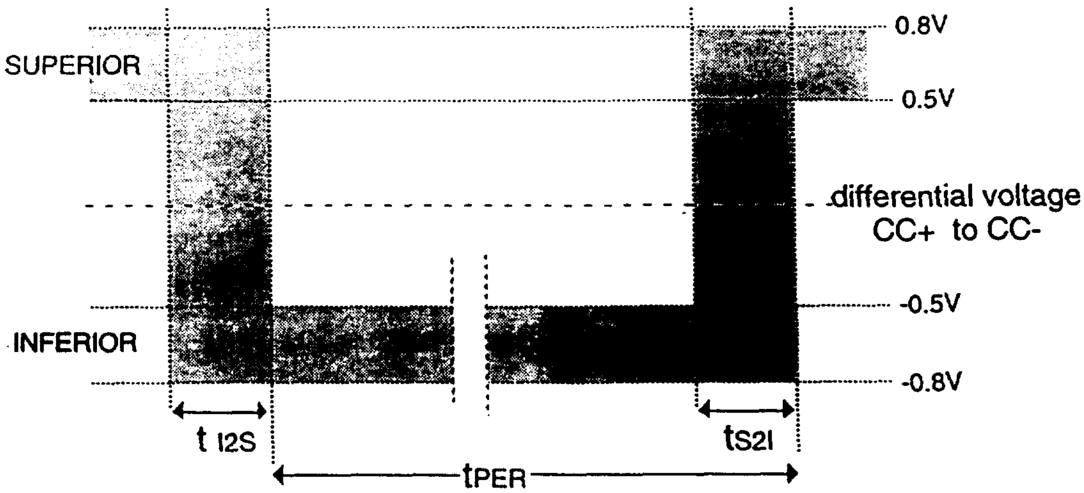

Figure 5.5 Output Waveform timing/voltage envelope

5.5.4 Common Mode Output Voltage

The magnitude of the common mode output voltage (Vcm) generated by the driver in either the SUPERIOR or INFERIOR state, measured between the midpoint of a test load shown in Figure 5.6, shall be +6.0 volts ±TBD volts.

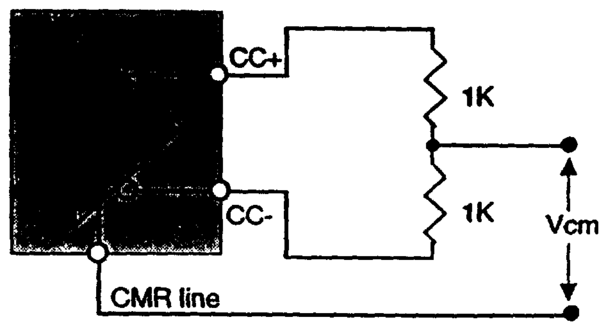

Figure 5.6 Common Mode Output Test Circuit

5.5.5 Fault Tolerance

The control channel transmitter, while in either the INFERIOR or SUPERIOR state, shall tolerate the application of each of the following faults indefinitely; and after the fault condition is removed, the operation of the transmitter shall not be impaired. In addition, the magnitude of the output current from the transmitter under any of the fault condition specified shall not exceed ±10 mA.

- Output terminals shorted together (not touching control channel lines)
- Output terminals shorted together and shorted to either side of the control channel lines
- Output terminals shorted together and shorted to the CMR line.
- The control channel lines shorted together while the device is properly connected

5.6 Control Channel Receiver Characteristics

The receiver shall permit correct decoding of a bipolar encoded waveform as described in Section 5.3.1 when the receiving interface circuit at the connector of the AV device is driven by an input signal meeting the state recognition requirements described below.

5.6.1 SUPERIOR State Recognition

The receiver will detect the transition to the SUPERIOR state—and report this state via a M_STATE.indicate(INFERIOR) service primitive—if a transition to a differential voltage level of <+0.8V to > +0.5V volts, CC+ to CC-, occurs within 6.4µs and remains <+0.8V and >+0.5V for 25µs ± 5µs (1/4 unit symbol time). Recognition will occur in the presence of a common mode voltage range of +2V to +7V appearing at the receiver input terminals with respect to the CMR line.

5.6.2 INFERIOR State Recognition

The receiver will detect a transition to the INFERIOR state—and report this transition via a M_STATE.indicate(SUPERIOR) service primitive—if a transition to a differential voltage level of > -0.5V to < -0.8V, CC+ to CC-, occurs within 6.4µs and remains > -0.5V to < -0.8V for 25µs ± 5µs (1/4 unit symbol time). Recognition will occur in the presence of a common mode voltage range of +2V to +7V appearing at the receiver input terminals with respect to the CMR line.

5.6.3 Receiver Input Impedance

The control channel receiver of an AV device shall have an input impedance measured at the device media terminals greater than 20K ohms over the frequency range 1KHz to 50KHz. These conditions shall be met in the power-off condition and during power-on while in the INFERIOR state. This impedance is measured at the device control channel terminals with a sine wave amplitude of 500 mV p–p.

5.6.4 Noise Immunity Requirements

The receiver will successfully detect either the SUPERIOR or INFERIOR state during the state recognition time provided the respective state is present for a minimum of 90% of the required state recognition time. Figure 5.7 illustrates the two cases of noise rejection required during the SUPERIOR and INFERIOR state recognition time.

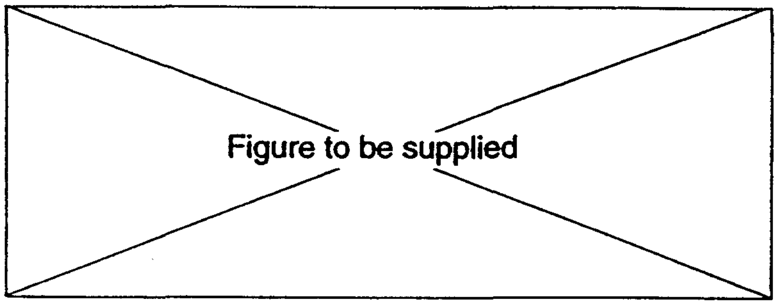

Figure 5.7 Noise Immunity Requirements

5.6.6 Receiver Fault Tolerance

The control channel receiver circuitry of the AV device should be able to tolerate the application of the following faults specified, and after the fault condition is removed, the operation of the receiver shall not be impaired.

- Input terminals shorted together (not touching control bus)
- Input terminals shorted together and shorted to either side of the control bus
- Input terminals shorted together and shorted to earth ground.
- The control bus shorted together while the device is properly connected

5.7 Data Channel Transmitter Characteristics

Any AV Bus data channel transmitter (both audio and video) is assumed to operate in one of two states: a low impedance active state in which signal is being applied to the medium; and a high impedance inactive state when no signal is being applied, and the device is either not powered, or in the receive mode of operation.

Only the transmitter and receiver parameters necessary to ensure electrical compatibility with other data channel devices, insure reliable data channel operation, and minimize media interference are specified in the following sections.

5.7.1 Audio Bus Transmitter

The following specifications apply to the interface of an audio device to the A1, A2, A3, and A4 media pairs. The interface requirements are identical for all audio media pairs. All parameters apply over the frequency range of 0 Hz to 20 KHz unless otherwise stated.

5.7.1.1 Active State
During the active, low impedance state the audio medium transmitter output impedance shall be 120 ohms ± TBD ohms between the audio medium connector pins. Output impedance shall be 60 ohms ±TBD ohms between each audio medium connector pin and the CMR line.

The *maximum*?? differential output voltage amplitude (Vdif) at the audio medium connector, driving the test circuit of Figure 5.8 in either switch position, will be 2V RMS.

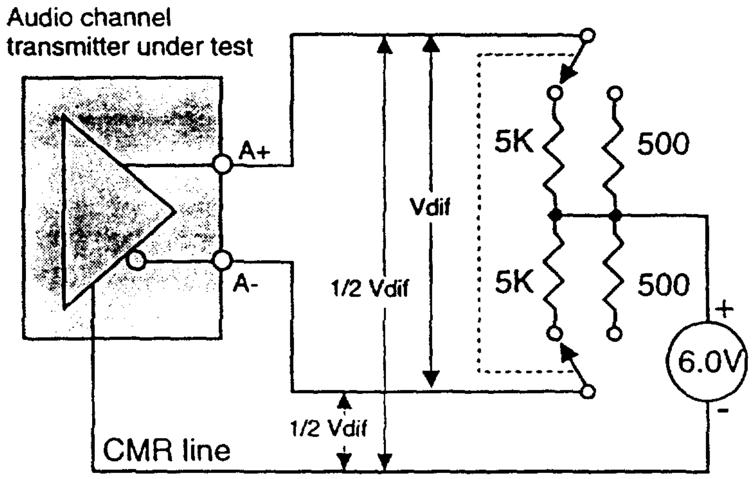

Figure 5.8 Audio Channel transmitter test circuit

The gain symmetry of all audio medium transmitters between audio medium lines will be less than 1% from DC to 20 KHz when driving the test circuit of Figure 5.8.

5.7.1.2 Inactive State
During the inactive, high impedance state the audio media transmitter circuit should maintain an output impedance between 10K ohms and 1M ohms. The output impedance should be between 5K ohms and 1M ohms between each audio medium connector pin and the CMR line. There will be less than 30µV p-p?? output signal into a 10K ohm load, at any frequency during the inactive state.

5.7.1.3 Common Mode Output Voltage
The magnitude of the common mode output voltage (Vcm) of the audio medium transmitter, in either the active or inactive state, measured between the midpoint of a test load shown in Figure 5.9 and the CMR line, shall be 6.0 V ±TBD volts.

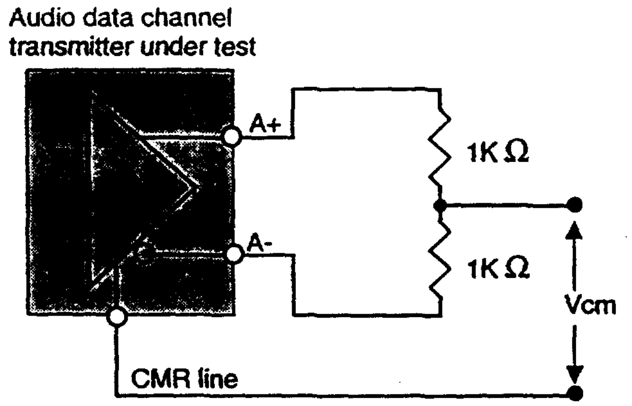

Figure 5.9 Audio Common Mode Output Test Circuit

5.7.1.4 DC Offset Voltage

The magnitude of the audio medium transmitter DC offset voltage, measured across the audio medium connector pins with a 10K ohm load, in either the inactive state or active state with no input signal, shall be less than ±TBD volts.

The change in the DC offset voltage while transitioning from the inactive state to the active state shall be less than ±TBD volts.

5.7.2 Video Bus Transmitter

The following specifications apply to the interface of a video device to the V1, V2, V3, and V4 medium pairs. The interface requirements are identical for all video media pairs. All parameters apply over the frequency range of 0Hz to 5.0MHz.

5.7.2.1 Active State

During the active, low impedance state the video medium transmitter output impedance shall be 120 ohms ± TBD ohms between the video medium connector pins. Output impedance shall be 60 ohms ±TBD ohms between each video medium connector pin and the CMR line.

The *maximum*?? differential output voltage amplitude (Vdif) at the video medium connector, driving the test circuit of Figure 5.8, will be 1 volt p-p ±TBD volts.

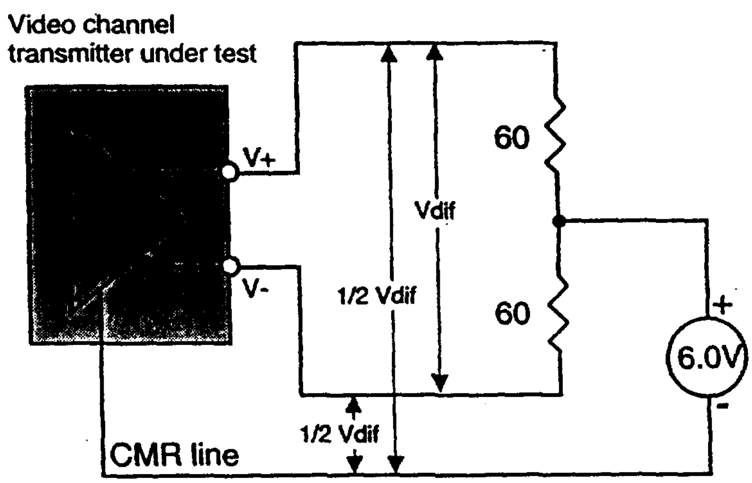

Figure 5.10 Video Channel transmitter test circuit

The gain symmetry of all video medium transmitters between video medium lines will be less than 1% from DC to 20 KHz when driving the test circuit of Figure 5.10.

5.7.2.2 Inactive State

During the inactive, high impedance state the video media transmitter circuit should maintain an output impedance between 3K ohms and 1M ohms. The output impedance should be between 1.5K ohms and 1M ohms between each video medium connector pin and the CMR line. There will be less than 30μV p-p?? output signal into a 60 ohm load, at any frequency during the inactive state.

5.7.2.3 Common Mode Output Voltage

The magnitude of the common mode output voltage (Vc) of the video medium transmitter, in either the active or inactive state, measured between the midpoint of a test load shown in Figure 5.11 and the CMR line, shall be 6.0 V ±TBD volts.

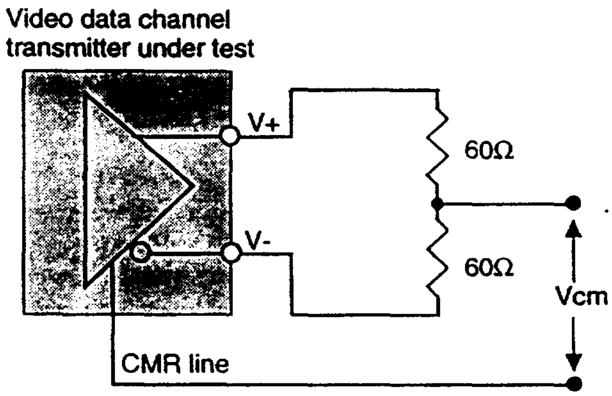

Figure 5.11 Video channel common mode output test circuit

5.7.2.4 DC Offset Voltage

The magnitude of the video medium transmitter DC offset voltage, measured across the video medium connector pins while connected to the test circuit of figure 5.10, in either the inactive state or active state with a 30 IRE input signal, shall be less than ±TBD volts.

The change in the DC offset voltage while transitioning from the inactive state to the active state shall be less than ±TBD volts.

5.7.3 Data Channel Transmitter Fault Tolerance

Any audio or video transmitter, while in either the active or inactive state, shall tolerate the application of each of the following faults indefinitely; and after the fault condition is removed, the operation of the driver shall not be impaired. In addition, the magnitude of the sink or source current from the driver under any of the fault condition specified shall not exceed 10mA.

- Output terminals shorted together (not touching medium).
- Output terminals shorted together and shorted to either or both conductors of the medium pair.
- Either or both output terminals shorted to CMR line.

5.8 Data Channel Receiver Characteristics

Any AV Bus data channel receiver on any AV media (both audio and video) is assumed to operate in a high impedance state. The following specifications must be meet while the device is connected to the media.

Only the receiver parameters necessary to ensure electrical compatibility with other data channel devices, insure reliable control channel operation, and minimize media interference are specified in the following sections.

5.8.1 Audio Bus Receiver

The following specifications apply to the interface of an audio receiving device to the A1, A2, A3, A4 pairs. The interface requirements are identical for all audio media. All parameters apply over the frequency range of 0 Hz to 20 KHz unless otherwise stated.

5.8.1.1 Audio Channel Input Impedance

The audio medium receiver shall have an input impedance, measured at the device audio media terminals, between 10K ohms and 1M ohms. The input impedance shall be between 5K ohms and 1M ohms between each audio medium connector pin and the CMR line. These conditions shall be met in the power-off or power-on condition. This impedance is measured at the audio medium terminals of the AV Bus connector with a differential sine wave amplitude of 1.0V p–p??.

5.8.1.2 Received Signal Conditions

The audio medium receiver shall operate normally with a received signal range of 2.0 volts RMS maximum while in the presence of a common mode voltage of 6.0 volts ±TBD volts from either audio terminal to reference GND (as shown in Figure 5.12), and a DC offset voltage of ≤ ±TBD between audio terminals.

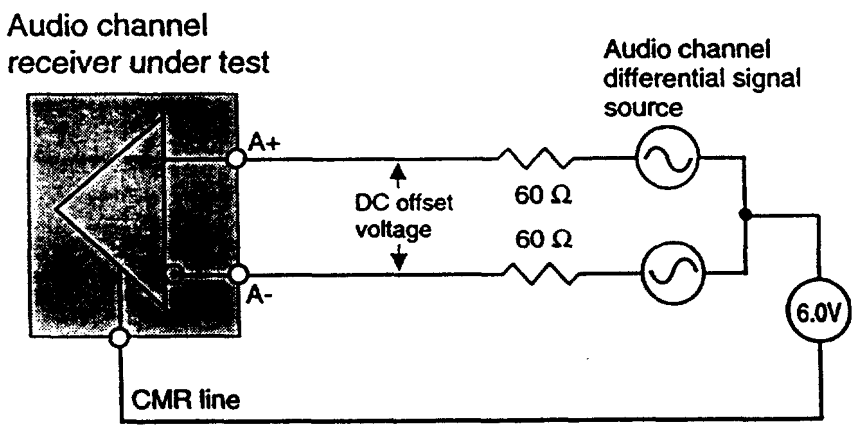

Figure 5.12 Audio receiver common mode test circuit

5.8.1.3 Common Mode Rejection Ratio

The audio receiver will have a common mode rejection ration ≥ 60 dB measured at 20 KHz.

5.8.1.4 Media Isolation

Any audio medium receiver will provide a minimum of 80dB of signal isolation between the connected medium and all other AV bus media and all other non-AV bus signals in or out of the AV device.